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Forest Insect and Disease Management

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BIOLOGICAL
EVALUATION R2-76-8

MOUNTAIN PINE BEETLE

Black Hills of South Dakota
and Wyoming
Black Hills National Forest &
Adjacent State and Private
Lands of South Dakota &
Wyoming

SEPTEMBER 1976

Rocky Mountain Region

U.S. Department of Agriculture Forest Service

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INTRODUCTION

The mountain pine beetle continues to cause heavy ponderosa pine mortality in the Black Hills of South Dakota and Wyoming. Losses are especially high in the Limestone area of western South Dakota, eastern Wyoming and on the southern Bear Lodge Mountains of Wyoming. An aerial survey to estimate the number of 1975-infested ponderosa pines was conducted in September 1976. Ground "strip cruises" were conducted soon after the beetle flight in September 1976, by FIDM evaluation group personnel, to determine the ratio of 1975- to 1976-infested trees. It is estimated that 611,000 ponderosa pine trees on all land ownerships became infested during August and early September 1976. The build-up of 1975-infested trees to 1976-infested trees averaged 1:1.47 on the Black Hills National Forest in South Dakota and Wyoming. A brood ratio survey conducted in late June 1976 also indicated an increasing population trend.[1/] Although build-up ratio cruises were conducted on Federal lands only, the average build-up ratio is probably applicable to all ownership lands in the Black Hills area. Salvage logging during 1975 and 1976 removed an estimated 310,000 1975-infested ponderosa pine trees on all ownership lands; including State and private lands in Wyoming and South Dakota, and the Black Hills National Forest. Suppression efforts should concentrate on silvicultural thinning of stands, along with salvage logging where such logging is conducted in conjunction with planned thinning projects.

TECHNICAL INFORMATION

Causal Agent: *Dendroctonus ponderosae* Hopkins. Mountain pine beetle.

Host Tree: *Pinus ponderosa* Laws. Ponderosa pine.

Extent of Infestation: The infestation continues in overstocked stands in the Black Hills National Forest and adjacent State, private and other Federal lands in South Dakota and Wyoming.

1/ Cahill, D. B., L. C. Yarger. Biological Evaluation R2-76-3. Mountain Pine Beetle. Black Hills of South Dakota and Wyoming. June 1976.

Life History: The mountain pine beetle has one generation per year. Adults attack trees during August and early September by boring through the bark to the cambium, then tunnel upward for 12 to 30 inches (these tunnels are called egg galleries). The females lay eggs in individual niches along each side of the gallery which is then packed with frass. After hatching, the larvae feed in individual channels (larval galleries) at right angles to the egg gallery, in the phloem. The insect overwinters in the larval stage. In the spring, when the larvae are fully developed they excavate an oval chamber (called a pupal chamber) at the end of the larval gallery and pupate. Mature adults emerge from these pupal chambers by boring through the outer bark surface and fly to attack new trees completing the generation.

METHODS

An aerial survey was conducted in August and September of 1976 to estimate and map the number and location of 1975-attacked ponderosa pine trees. From this mapping, and with the assistance of Black Hills National Forest and South Dakota State Forestry personnel, areas were selected on National Forest land where ground surveys would produce sufficient data in terms of 1975- and 1976-infested trees to determine the ratio of 1976-infested trees to those infested in 1975. (Figure 3)

Ground surveys, in the form of "strip cruises", were conducted in late September when the beetle flight period was complete. Each individual build-up survey line consisted of 2 parallel cruises, 5 or 10 chains apart, 1 mile long, and 1 chain wide. All 1975- and 1976-infested trees were tallied by DBH, within the 1 chain wide cruise area. Basal area was measured at 5 chain intervals along each line to indicate stocking level (Table 1).

For the build-up ratio survey the areas picked were selected because of known presence of mountain pine beetle infestation. Such pre-selection of survey areas can cause bias in the estimate but is necessary to obtain as much information as possible about the population of interest which in this case consists of beetle infested trees. As the number of infested trees tallied increases, the accuracy of the estimate also increases.

RESULTS

From this year's aerial survey and ratio cruises data it is estimated that the mountain pine beetle killed over 611,000 ponderosa pine trees in the Black Hills. Approximately 416,000

red tops were counted in the aerial survey. Twenty-four areas were ground-surveyed to determine build-up ratios (Figure 1). There was not enough beetle damage noted from the aerial survey and from a ground check to warrant running ground survey lines on the southern ranger districts of the Black Hills National Forest.

The estimate of a build-up ratio of trees attacked in 1976 to trees attacked in 1975 is 1.47 to 1. Using the aerial survey estimate of 416,000 standing 1975 infested trees, the estimate for the number of trees attacked in 1976 is 611,520. Placing a 90% confidence interval on the ratio estimate gives high and low estimates of the build-up ratio of 1 to 1.59 to 1 to 1.36. Converting these ratio estimates to trees we can estimate the number of 1976 infested trees to be between 661,440 and 565,760 trees. Because of the bias associated with the preselection of survey areas, and since no estimate of variability is available for the aerial survey upon which the build-up ratio is applied, it is quite possible that the exact number of infested trees differs from this estimate. However, we feel that this is a good estimate.

Table 1 shows the numbers of infested trees by survey area and ranger district. Average diameters and standard errors, and the length of each line in miles is also shown. The build-up ratio for each line and district is also given along with a 90% confidence interval estimate for the build-up ratio by ranger district. Appendix A outlines the method used for calculating the build-up ratio confidence intervals.

During the strip cruise surveys, variable point plots were established at 5 chain intervals. A total of 316 plots were recorded. The data recorded was total B.A., live tree B.A., and B.A. of trees lost to mountain pine beetle. Analysis of the data from the variable plots indicated a significant relationship between B.A. (basal area, sq ft per acre) per plot and B.A. loss to the mountain pine beetle (Figure 1). A regression analysis of the data fitted the general form of an exponential curve ($Y = ax^b$)2/. Based on the 316 observations in 1976 (Table 2), the average B.A. lost to the mountain pine beetle increased as the B.A. of the plot increased (cofficient of correlation = 0.8542). Stands with a high B.A. will probably sustain a higher loss to mountain pine beetle.

2/
Y = mean B. A. lost to the mountain pine beetle
x = B. A. per plot
b = slope
a = y intercept

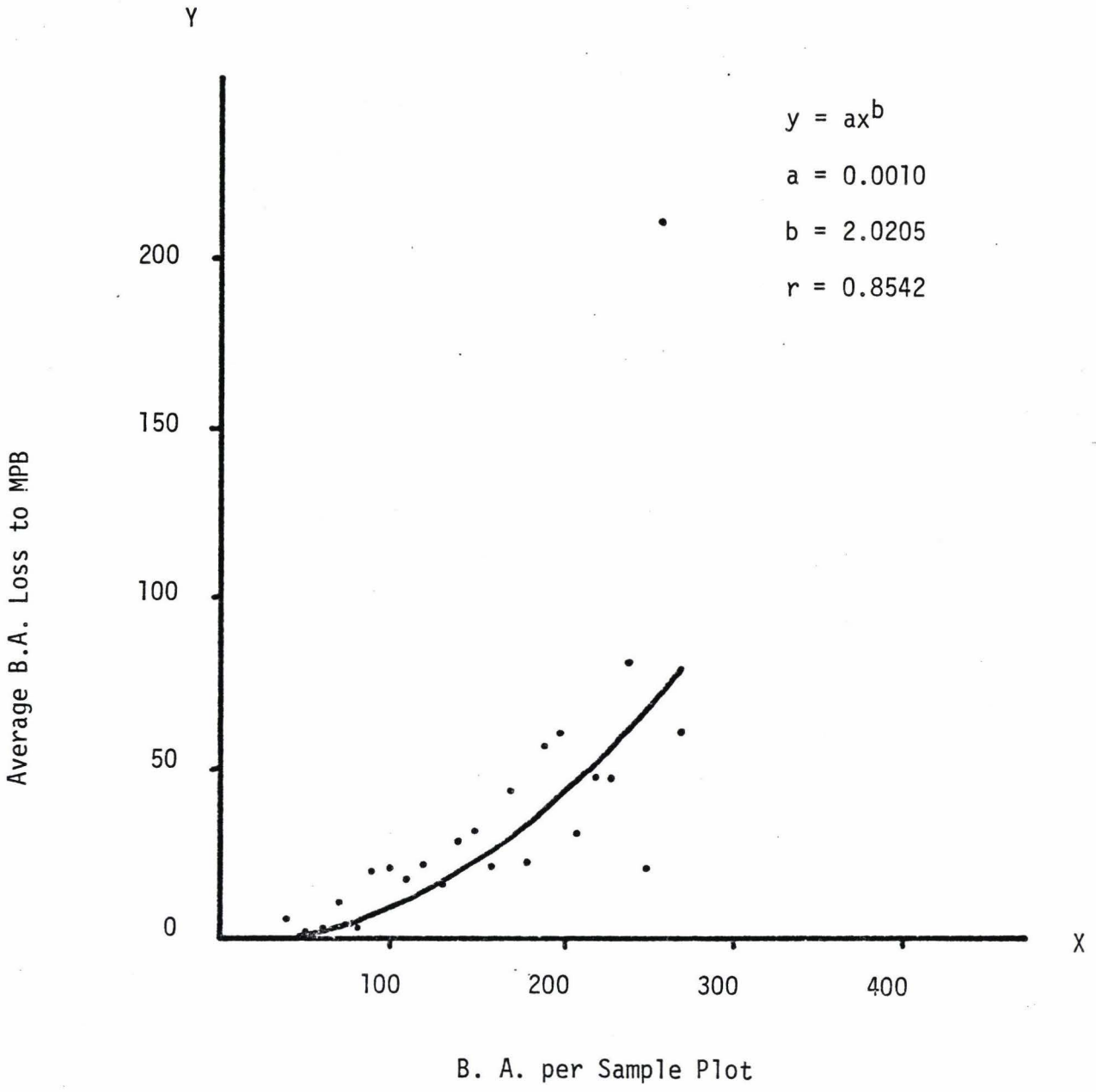

Figure 1 Exponential regression for B.A. class (based on 316 variable sample plots) versus average B.A. loss to mountain pine beetle in the Black Hills National Forest.

DISCUSSION

One of the most effective methods of suppressing the mountain pine beetle is through a combined program of timely logging of infested trees and silvicultural treatments to reduce stand basal area. Suppression efforts should not rely entirely on logging of infested trees. Although logging of infested trees provides immediate relief in a given stand, this does little to insure against recurring losses within the remaining stand. [3/]

Care should be taken during logging operations to insure that all infested trees are felled and removed before beetle flight. Figure 2 shows an area in which all infested trees were not removed, resulting in heavy losses after the salvage logging had supposedly been completed. Improper suppression efforts such as this will not aid in suppressing the mountain pine beetle. Timber sale administrators should insure that cutters are felling all infested trees and that the cut timber is hauled out of the forest before beetle flight. Markers should work just ahead of fallers and areas cut should be checked before falling proceeds too far for the fallers to go back and cut any missed trees.

Thinning of overstocked groups of trees to a growing stock level of 80 to 90 improves the growth of crop trees in diameter, volume and height. Stands with healthy, vigorous-growing trees are not as susceptible to losses by the mountain pine beetle as are slower-growing or stagnated stands.

ALTERNATIVES

Alternative 1: Silvicultural treatment of all operable stands to reduce growing stock levels to 80 or 90. This will effectively reduce susceptiability of stands to mountain pine beetle attack for periods of 20 years or more. Uneven age stand management often requires partial cutting in stands every 20 years. Therefore, the concept of reducing growing stock levels to 80 to 90, with the expected protection of the stand from beetle attack for 20 years or more, agrees with current timber management techniques.

3/ Sartwell, C. and R. E. Dolph. Silvicultural and direct control of mountain pine beetle in second growth ponderosa pine. USDA Pacific Northwest Range and Experiment Station Research Note PNW-268. Jan., 1976.

Figure 2 - Improper mountain pine beetle suppression effort.

Alternative 2: Salvaging of infested timber would remove dead or dying trees so that they may be utilized rather than wasted. This proposal will not reduce the susceptibility of the stands to mountain pine beetle attack. The stands may become reinfested within a few years. Salvage logging should only be used in areas where the remaining stand will receive silvicultural treatment within 3 or 4 years. Salvage logging alone is only a temporary measure to reduce beetle populations and cannot be expected to give protection to a stand for more than 3 or 4 years.

Alternative 3: Doing nothing to alleviate the pressure of mountain pine beetle attack on Black Hills ponderosa pine forests cannot generally be justified from timber management or recreation management points of view. The mountain pine beetle, in epidemic proportions, will probably reduce growing stock below satisfactory levels for timber management. Dead trees will also increase fire hazard for a few years. During very high or extreme fire danger, forests may have to be closed down during high recreational use times because of the low fuel moisture content of large amounts of available fuel. Fire may further reduce timber inventory.

Alternative 4: Direct control by chemical treatment or burning of infested timber in a few cases in Region 2, may be an alternative. In order to use direct control a benefit/cost analysis should be done. Silviculturally or biologically, direct control cannot be justified. Direct control is only a temporary course of action which will not protect a stand from beetle attack for more than 3 or 4 years. Furthermore, the treated trees are not utilized and no return is realized on the high investment needed for direct control.

RECOMMENDATIONS

Of the alternatives, number 1 is recommended as the primary tool for land managers in the Black Hills. Alternative 2 should only be used when an area is to receive silvicultural treatment in the next 3 or 4 years. Alternative 3 should be put into effect in inaccessible areas where a choice of alternatives does not exist. At the present time, alternative 4 is not recommended. Land managers should do a benefit/cost analysis to determine whether or not alternative 4 could be beneficial.

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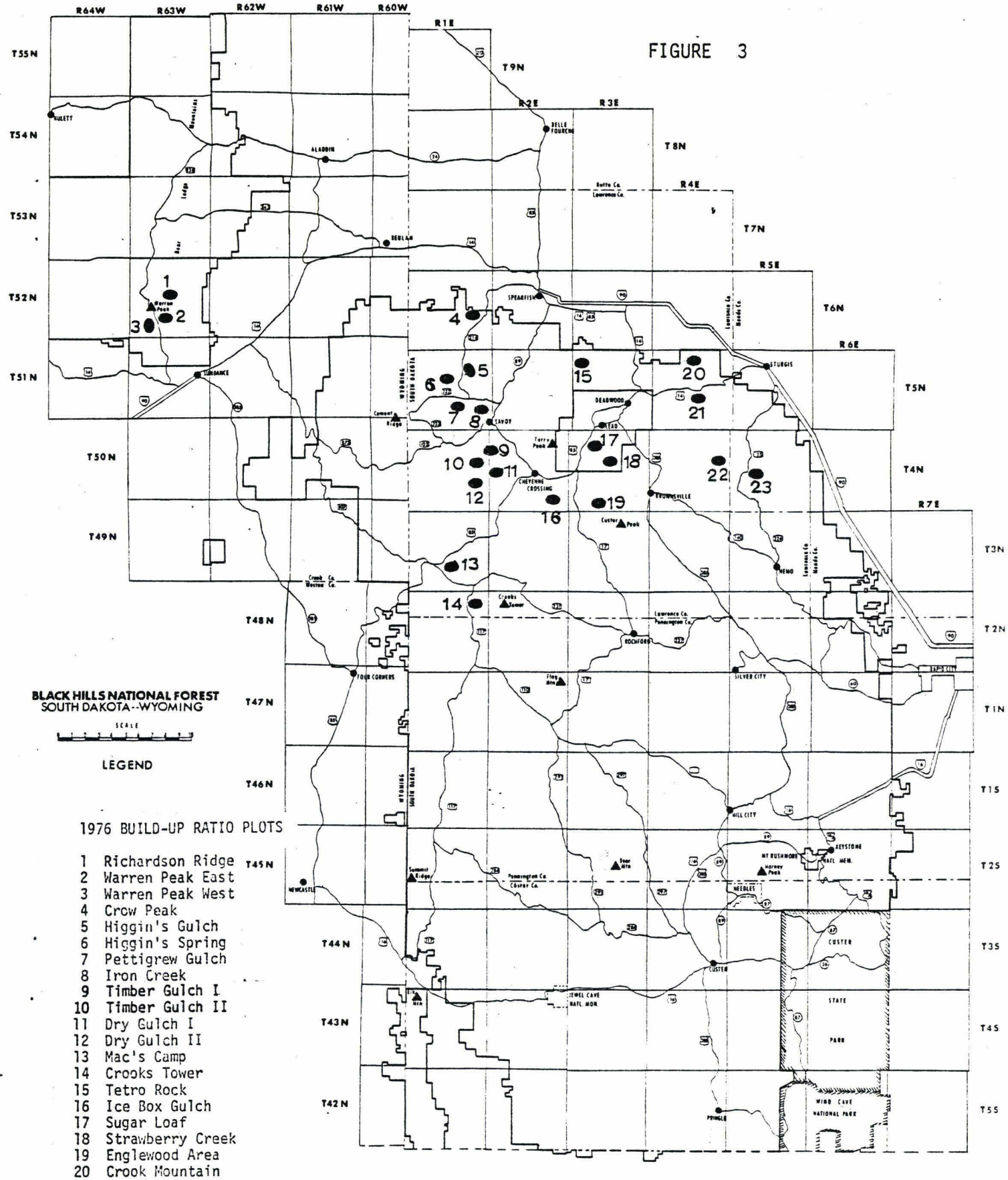
Thanks is also extended to Black Hills National Forest and South Dakota State Forest Service personnel who aided in the survey.

FIGURE 3



BLACK HILLS NATIONAL FOREST
SOUTH DAKOTA--WYOMING

SCALE

LEGEND

1976 BUILD-UP RATIO PLOTS

1 Richardson Ridge
2 Warren Peak East
3 Warren Peak West
4 Crow Peak
5 Higgin's Gulch
6 Higgin's Spring
7 Pettigrew Gulch
8 Iron Creek
9 Timber Gulch I
10 Timber Gulch II
11 Dry Gulch I
12 Dry Gulch II
13 Mac's Camp
14 Crooks Tower
15 Tetro Rock
16 Ice Box Gulch
17 Sugar Loaf
18 Strawberry Creek
19 Englewood Area
20 Crook Mountain
21 Boulder Creek
22 Kirk Hill
23 Tillson Creek

TABLE 1

STRIP CRUISE BUILD-UP RATIO DATA

BLACK HILLS NATIONAL FOREST 1976

District Area	Miles of Line	1976 Infested Trees Number	1976 Infested Trees Ave. DBH ± Stand Error	1975 Infested Trees Number	1975 Infested Trees Ave. DBH ± Stand Error	Build-up Ratio
BEARLODGE R. D.						
Richardson Ridge	1.00	8	12.13 ± .46	0	0.00 ± 0.00	
Warren Peak East	1.25	23	13.94 ± .49	3	16.60 ± .21	1 : 7.67
Warren Pest West	1.25	27	10.25 ± .51	31	8.99 ± .22	1 : .87
	3.50	58	11.97 ± .38	34	9.66 ± .43	1 : 1.71
SPEARFISH R. D.						
Crow Peak	1.25	106	11.52 ± .35	235	10.38 ± .17	1 : .45
Higgins Bulch	.88	41	10.60 ± .43	4	13.50 ± 1.35	1 :10.25
Higgins Spring	.88	7	13.97 ± .68	13	10.96 ± .67	1 : .54
Pettigrew Gulch	1.56	52	10.89 ± .44	46	10.48 ± .35	1 : 1.13
Iron Creek	1.25	268	10.69 ± .16	118	11.36 ± .23	1 : 2.27
Timber Gulch 2	1.06	121	10.43 ± .36	72	10.74 ± .21	1 : 1.68
Timber Gulch 1	.75	31	9.47 ± .22	33	9.26 ± .24	1 : .94
Dry Gulch 1	1.13	164	10.83 ± .21	97	11.58 ± .27	1 : 1.69
Dry Gulch 2	1.06	44	9.45 ± .25	29	10.46 ± .48	1 : 1.52
Mac's Camp	1.19	6	13.53 ± 2.24	31	16.21 ± .96	1 : .19
Crooks Tower	1.25	3	13.10 ± 4.97	7	17.51 ± 1.74	1 : .43
Ice Box Gulch	1.13	145	12.22 ± .24	62	11.87 ± .30	1 : 2.34
	13.39	988	10.96 ± .09	747	11.15 ± .11	1 : 1.32
NEMO & HARNEY R. D.'s						
Tetro Rock	.44	108	9.64 ± .23	37	11.93 ± .44	1 : 2.92
Sugarloaf	1.19	75	12.61 ± .39	26	12.78 ± .47	1 : 2.88
Strawberry Creek	.56	0	0.00 ± 0.00	3	13.10 ± .83	---
Englewood Area	1.25	89	8.85 ± .27	110	9.71 ± .24	1 : .81
Crook Mountain	1.00	66	10.04 ± .30	0	0.00 ± 0.00	---
Boulder Creek	.94	14	12,06 ± .63	29	10.59 ± .55	1 : .48
Kirk Hill	1.25	54	12.21 ± .33	4	12.80 ± .94	1 :13.50
Tillson Creek	1.19	4	11.70 ± 1.06	0	0.00 ± 0.00	---
	7.82	410	10.52 ± .15	209	10.71 ± .20	1 : 1.96
	24.71	1456	10.87 ± .08	990	11.00 ± .09	1 : 1.47

90% Confidence Intervals for Build-up Ratio

AREA	Mean Estimate	High Estimate	Low Estimate
BEARLODGE R. D.	1 : 1.71	1 : 2.70	1 : 1.13
SPEARFISH R. D.	1 : 1.32	1 : 1.45	1 : 1.20
NEMO & HARNEY R. D.'s	1 : 1.96	1 : 2.32	1 : 1.67
TOTAL	1 : 1.47	1 : 1.59	1 : 1.36

TABLE 2 VARIABLE PLOT SAMPLES FOR THE BLACK HILLS NATIONAL FOREST IN 1976, AVERAGE BASAL AREA LOSS TO MOUNTAIN PINE BEETLE BY BASAL AREA CLASS

No. Plots	Basal Area per Acre (sq. ft.)	Average Basal Area per Acre (sq. ft.) Loss to MPB	% Loss
6	40	5.0	12.5
12	50	0.8	1.6
9	60	1.1	1.8
19	70	10.0	14.3
11	80	2.7	3.3
17	90	19.4	21.5
32	100	20.3	20.3
24	110	16.7	15.2
28	120	21.4	17.8
33	130	16.4	12.6
17	140	28.2	20.1
19	150	31.0	20.7
22	160	20.9	13.1
15	170	43.3	25.5
13	180	22.3	12.4
8	190	56.2	29.6
9	200	60.0	30.0
6	210	30.0	14.3
7	220	47.1	21.4
3	230	46.7	20.3
1	240	80.0	33.3
1	250	20.0	8.0
2	260	210.0	80.8
2	270	60	22.2

Total 316

APPENDIX A CALCULATION OF CONFIDENCE INTERVALS FOR BUILD-UP RATIOS [4/]

Given:

The population of interest consists of mountain pine beetle infested trees. This population consists of two classes: (1) trees infested in 1976, (2) trees infested in 1975. Confidence intervals for the build-up ratio estimate are computed as follows:

A = Number of trees infested in 1976 counted in a given area

B = Number of trees infested in 1975 counted in a given area

N = A + B = Total of 1975 & 1976 infested trees counted in a given area

$p = \frac{A}{B}$ = proportion of total trees counted which were infested in 1976

$q = \frac{B}{N}$ = proportion of total trees counted which were infested in 1975

C.I. = Confidence Interval

90% C.I. for q is expressed as: $q \pm 1.96 \sqrt{\frac{pq}{N}}$

Example: For the combined Black Hills build-up ratio surveys

A = 1456 B = 990 N = A + B = 2446

$p = \frac{A}{N} = \frac{1456}{2446} = .595$ $q = \frac{B}{N} = \frac{990}{2446} = .405$

90% C.I. for q is: $q \pm 1.96 \sqrt{\frac{pq}{N}} = .405 \pm 1.96 \sqrt{\frac{.595 \times .405}{2446}} = .405 \pm .019$

High and low estimate of q = $.405 \pm .019$ = .424 to .386

For build-up ratio purposes make q = 1

Then: mean estimate = $.405 : \frac{.595}{.405}$ or 1:1.47

90% C.I. expressed as $.424 : \frac{1-.424}{.424}$ = 1:1.36 and $.386 : \frac{1-.386}{.386}$ = 1:1.59

Build-up ratio with 90% C.I. is 1:1.47 Range is 1:1.59 to 1:1.36

4/ Snedecor, G. W. and W. G. Cochran. 1974. Statistical methods. Iowa State University. Ames, Iowa. 593 pp.